"Genetically Engineered" Nanostructure Devices

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The goal to reduce payload in future space missions while increasing mission capability demands miniaturization of measurement and analytical systems. Currently, typical system capabilities include the detection of particular spectral lines, associated data processing, and communication of the acquired data to other subsystems. While silicon device technology dominates the microprocessor and memory market, semiconductor heterostructure devices maintain their niche for light detection, light emission, and high-speed data transmission. The design and optimization of semiconductor heterostructure devices such as heterostructure field effect transistors (HFETs), resonant tunneling diodes (RTDs), quantum well infrared photodetectors (QWIPs), and quantum well lasers requires a detailed understanding of material properties and their influence on electron transport through the devices. In this work the RTD is used as a vehicle to study effects layer thickness and doping variations. The Nanoelectronic Modeling tool (NEMO) [1] was combined with a parallelized genetic algorithm package (PGAPACK) [2] to optimize structural and material parameters. The electron transport simulations are based on a full band simulation, including effects of non-parabolic bands in the longitudinal and transverse directions relative to the electron transport. The first results of the genetic algorithm driven quantum transport calculation are presented. Future work on the analysis of different material systems and the material parameter optimization using this approach will be outlined.

[1] Roger Lake, Gerhard Klimeck, R. Chris Bowen and Dejan Jovanovic, J. of Appl. Phys. 81, 7845 (1997).
[2] David Levine, Technical Report Argonne Natl. Laboratory, ANL-95/18.

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